We claim:

1. A method of lowering the dielectric constant and increasing the thermal stability and mechanical stability of a low k dielectric layer on a substrate, comprising:

(a) providing a substrate;

(b) forming a low k dielectric layer comprised of an organosilicon material on said substrate;

(c) performing a first treatment comprised of He plasma on said low k dielectric layer in a process chamber to form a transformed low k dielectric layer; and

(d) performing a second treatment comprised of H_2 plasma on said transformed low k dielectric layer in a process chamber.

2. The method of claim **1** further comprised of curing the low k dielectric layer before performing the He plasma treatment.

3. The method of claim **1** wherein the low k dielectric layer is comprised of carbon doped silicon oxide, hydrogen silsesquioxane (HSQ), or methyl silsesquioxane (MSQ).

4. The method of claim **3** wherein said carbon doped oxide layer is SiCOH with a composition of about 15-18 atomic % Si, about 28-30 atomic % oxygen, about 16-18 atomic % carbon, and about 36-38 atomic % hydrogen.

5. The method of claim **1** wherein the first and second treatments are performed with a plasma enhanced CVD (PECVD) process.

6. The method of claim **1** wherein said first and second treatments include a gas flow rate from about 1500 to 6000 standard cubic centimeters per minute (sccm).

7. The method of claim **1** wherein the first and second plasma treatments are each performed during a period of about 10 to 360 seconds.

8. The method of claim **1** wherein the process chamber pressure during said first and second treatments is between about 1 mTorr and 20 Torr.

9. The method of claim **1** wherein the He plasma in said first treatment and the H_2 plasma in said second treatment is generated by applying a RF power between about 300 and 2500 Watts.

10. The method of claim **1** wherein said substrate is heated between about 100°C and 500°C during said first and second treatments.

11. The method of claim **1** wherein said second treatment is performed in the same process chamber as said first treatment without breaking a vacuum between the two treatments.

12. The method of claim **1** wherein the transformed low k dielectric layer has a top portion that becomes enriched in Si-H bonds during the H_2 plasma treatment.

13. A method of lowering the dielectric constant and increasing the thermal stability and mechanical stability of a low k dielectric layer in a damascene process, comprising:

(a) providing a substrate having an etch stop layer formed thereon;

(b) depositing a low k dielectric layer comprised of an organosilicon compound on said etch stop layer;

(c) performing a first treatment comprised of He plasma on said low k dielectric layer in a process chamber to form a transformed low k dielectric layer;

(d) performing a second treatment comprised of H_2 plasma on said transformed low k dielectric layer to form a composite low k dielectric layer comprised of a transformed low k dielectric layer that is enriched in Si-H bonds on a transformed low k dielectric layer that has a mechanically stabilized network of Si-O bonds;

(e) forming an opening in said composite low k dielectric layer that extends through said etch stop layer; and

(f) depositing a diffusion barrier layer on the sidewalls of said opening, depositing a metal layer on said diffusion barrier layer that fills said opening, and planarizing said metal layer and said diffusion barrier layer to a level that is coplanar with said composite low k dielectric layer.

14. The method of claim **13** further comprised of curing the low k dielectric layer before performing the He plasma treatment.

15. The method of claim **13** wherein the low k dielectric layer is comprised of carbon doped silicon oxide, HSQ, or MSQ and has a thickness between about 1000 and 10000 Angstroms.

16. The method of claim **15** wherein the low k dielectric layer is a carbon doped silicon oxide layer which is SiCOH with a composition of about 15-18 atomic % Si, about 28-30 atomic % oxygen, about 16-18 atomic % carbon, and about 36-38 atomic % hydrogen

17. The method of claim **13** wherein said first and second treatments each include a gas flow rate from about 1500 to 6000 sccm and have a duration from about 10 to 360 seconds

18. The method of claim **13** wherein the process chamber pressure during said first and second treatments is between about 1 mTorr and 20 Torr.

19. The method of claim **13** wherein the He plasma in said first treatment and the H_2 plasma in said second treatment is generated by applying a RF power between about 300 and 2500 Watts.

20. The method of claim **13** wherein said substrate is heated to a temperature between about 100°C and 500°C during said first and second treatments.

21. The method of claim **13** wherein the transformed low k dielectric layer enriched in Si-H bonds has a thickness from about 1000 to 3000 Angstroms.

22. The method of claim **13** wherein said first treatment is performed in the same process chamber as said second treatment.

23. The method of claim **13** wherein the diffusion barrier layer is comprised of one or more of Ta, TaN, TaSiN, Ti, TiN, W, or WN and the metal layer is copper.

24. A method of lowering the dielectric constant and increasing the thermal stability and mechanical stability of a low k dielectric layer in an interconnect structure, comprising:

(a) providing a substrate with a metal layer comprised of metal lines having a top surface and sidewalls formed thereon and an anti-reflective coating (ARC) formed on the top surface of said metal lines;

(b) depositing an oxide layer comprised of one or more conformal oxide layers on said substrate, on the sidewalls of said metal lines, and on said ARC;

(c) depositing a low k dielectric layer comprised of an organosilicon material on said conformal oxide layer by a CVD, PECVD, or spin-on method;

(d) curing said low k dielectric layer;

(e) performing a first treatment comprised of a He plasma on said low k dielectric layer in a process chamber to form a transformed low k dielectric layer; and

(f) performing a second treatment comprised of a H_2 plasma on said transformed low k dielectric layer in a process chamber to form a composite low k dielectric layer

comprised of a transformed low k dielectric layer that is enriched in Si-H bonds on a transformed low k dielectric layer that has a mechanically stabilized network of Si-O bonds.

25. The method of claim **24** further comprised of planarizing said composite low k dielectric layer.

26. The method of claim **24** wherein said ARC is a TiN layer.

27. The method of claim **24** wherein the low k dielectric layer is comprised of carbon doped silicon oxide, HSQ, and MSQ and has a thickness between about 1000 and 10000 Angstroms.

28. The method of claim **27** wherein the low k dielectric layer is a carbon doped silicon oxide layer which is SiCOH with a composition of about 15-18 atomic % Si, about 28-30 atomic % oxygen, about 16-18 atomic % carbon, and about 36-38 atomic % hydrogen

29. The method of claim **24** wherein said first and second treatments each include a gas flow rate from about 1500 to 6000 sccm and have a duration from about 10 to 360 seconds

30. The method of claim **24** wherein the chamber pressure during said first and second treatments is between about 1 mTorr and 20 Torr.

31. The method of claim **24** wherein the He plasma in said first treatment and the H_2 plasma in said second treatment is generated by applying a RF power between about 300 and 2500 Watts.

32. The method of claim **24** wherein said substrate is heated to a temperature between about 100°C and 500°C during said first and second treatments.

33. The method of claim **24** wherein said transformed low k dielectric layer enriched in Si-H bonds has a thickness from about 1000 to 3000 Angstroms.

34. The method of claim **24** wherein said first treatment and the second treatment are performed in the same process chamber.

35. A damascene structure comprising:

(a) a planar substrate;

(b) an etch stop layer formed on said planar substrate;

(c) a composite low k dielectric layer comprised of an organosilicon material formed on said etch stop layer, said composite low k dielectric layer has an upper layer which is enriched in Si-H bonds and has a top surface and a lower layer with a mechanically strengthened network of Si-O bonds;

(d) an opening formed in said composite low k dielectric layer that extends through said etch stop layer;

(e) a diffusion barrier layer on the sidewalls of said opening; and

(f) a metal layer formed on said diffusion barrier layer, said second metal layer fills said opening and has a top surface that is coplanar with the top surface of said composite low k dielectric layer.

36. The damascene structure of claim **35** wherein the metal layer is comprised of copper, tungsten, aluminum or Al/Cu.

37. The damascene structure of claim **35** wherein the diffusion barrier layer is one or more of Ta, TaN, Ti, TiN, W, WN, or TaSiN.

38. The damascene structure of claim **35** wherein the etch stop layer is silicon carbide, silicon nitride, or silicon oxynitride.

39. The damascene structure of claim **35** wherein the organosilicon material in the composite low k dielectric layer is HSQ, MSQ, or carbon doped silicon oxide.

40. The damascene structure of claim **39** wherein the carbon doped silicon oxide layer is SiCOH having a composition of about 15-18 atomic % Si, about 28-30 atomic % oxygen, about 16-18 atomic % carbon, and about 36-38 atomic % hydrogen.

41. The damascene structure of claim **35** wherein the dielectric constant and the polish rate of the composite low k dielectric layer are lower than can be obtained by depositing and curing an organosilicon layer of a similar composition.

42. The damascene structure of claim **35** wherein the composite low k dielectric layer has a thickness from about 1000 to 10000 Angstroms.

43. The damascene structure of claim **35** wherein the substrate is further comprised of a conductive layer having an exposed top surface and wherein the metal layer is formed above said conductive layer.

44. An interconnect structure comprising:

(a) a planar substrate having an exposed first metal layer comprised of metal lines and a dielectric layer which separates the metal lines within said first metal layer;

(b) a second metal layer comprised of metal lines that are aligned above and are in contact with the metal lines in said first metal layer, each line in the second metal layer is aligned above at least one line in the first metal layer and each line in the second metal layer has a top surface and sidewalls;

(c) an anti-reflective coating (ARC) formed on the top surface of each line in said second metal layer;

(d) a conformal oxide layer formed on the sidewalls of said metal lines in said second metal layer and on the ARC, said conformal oxide layer is also formed on said substrate between said metal lines in the second metal layer; and

(e) a composite low k dielectric layer comprised of an organosilicon material formed on said conformal oxide layer, said composite low k dielectric layer has an upper layer that is enriched in Si-H bonds and a lower layer that covers the metal lines in said second metal layer and has a mechanically strengthened network of Si-O bonds.

45. The interconnect structure of claim **44** wherein the first and second metal layers are comprised of copper, tungsten, aluminum or Al/Cu.

46. The interconnect structure of claim **44** wherein the ARC is TiN.

47. The interconnect structure of claim **44** wherein the conformal oxide layer is a silicon rich oxide (SRO) layer.

48. The interconnect structure of claim **44** wherein the conformal oxide layer is undoped silicon glass (USG).

49. The interconnect structure of claim **44** wherein the conformal oxide layer is comprised of a USG layer on a SRO layer.

50. The interconnect structure of claim **44** wherein the composite low k dielectric layer is comprised of HSQ, MSQ, or a carbon doped silicon oxide with a thickness about 2000 to 8000 Angstroms above the second metal layer.

51. The interconnect structure of claim **50** wherein the carbon doped silicon oxide is SiCOH having a composition of about 15-18 atomic % Si, about 28-30 atomic % oxygen, about 16-18 atomic % carbon, and about 36-38 atomic % hydrogen.

52. The interconnect structure of claim **44** wherein the dielectric constant and the CMP polish rate of the composite low k dielectric layer is lower than can be obtained by depositing and curing a low k dielectric layer of a similar organosilicon composition.